

occurred over the years. Most of these spills and leaks have consisted of petroleum-related products and solvents from USTs, drums, and uncontained waste storage areas.

1.3 Previous Investigations

In response to the passage of the CERCLA Act of 1980, the DON initiated the Navy Assessment and Control of Installation Pollutants (NACIP) program to identify, investigate, and clean up past hazardous waste disposal sites at Navy installations. The NACIP investigations conducted by the DON consisted of Initial Assessment Studies (IAS), similar to the USEPA's Preliminary Assessments/Site Investigations (PA/SI) and Confirmation Studies, similar to the USEPA's RI/FS. When the Superfund Amendment and Reauthorization Act (SARA) was passed in 1986, the DON aborted the NACIP program in favor of the IRP, which adopted the USEPA Superfund procedures.

An IAS was conducted at MCB Camp Lejeune by Water and Air Research, Inc. (WAR) in 1983. The IAS identified a number of sites at MCB Camp Lejeune as potential sources of contamination, including the three sites discussed in this RI. The IAS included a review of historical records and aerial photographs, as well as field inspections and personnel interviews to evaluate potential hazards at various sites at MCB Camp Lejeune. The IAS recommended performing further investigations at Sites 21 and 24 to assess potential long-term impacts. Site 78 was later added to the list of sites to be further evaluated. The remainder of this section discusses the previous investigations that were conducted at each of the three sites based on the results of the IAS.

1.3.1 Site 21 Previous Investigations

Previous investigations conducted solely for Site 21 consisted of a Confirmation Study and an Aerial Photographic Study. Both of these are discussed below.

1.3.1.1 Confirmation Study

As a result of the IAS, Environmental Science and Engineering, Inc. (ESE) was contracted by the DON to investigate Site 21. ESE conducted a two part Confirmation Study, which focused on the potential source areas identified in the IAS (WAR, 1983). The Confirmation Study included a Verification Step and a Characterization Step. The findings from the Confirmation Study as they pertain to Site 21 are described below.

Soil Sample Results

In August 1984, ten soil borings were hand augered at this site. Four of the borings were located inside the fenced area and six borings were located outside the fenced area. The exact location of these borings was not documented. Six samples were collected from the four borings located inside the fence and analyzed for organochlorine pesticides and herbicides, and polychlorinated biphenyls (PCBs). Detectable amounts of 4,4'-DDD [0.0006 to 0.0074 microgram per gram ($\mu\text{g/g}$)], 4,4'-DDE (0.0031 to 0.074 $\mu\text{g/g}$), and 4,4'-DDT (0.0057 to 0.087 $\mu\text{g/g}$) were found in all the samples collected from the borings at both sampled depths (from the surface and between 1 to 2 feet). PCBs were not detected in any of the samples. Table 1-2 presents a summary of the range of concentrations detected during the August 1984 sampling event.

Six additional soil samples were collected in 1984 from six borings located outside the fence area. The exact location of these borings was not documented. These samples were collected at the surface and at the 1 to 2 foot range. These samples were analyzed for organochlorine pesticides and herbicides. Three pesticides, 4,4'-DDD (0.0036 to 0.023 $\mu\text{g/g}$), 4,4'-DDE (0.0079 to 0.22 $\mu\text{g/g}$), and 4,4'-DDT (0.014 to 2.1 $\mu\text{g/g}$) were detected in all of the soil samples collected (ESE, 1990). The results are summarized on Table 1-2.

In November 1986, eight additional soil borings were augered outside the fenced area in order to further delineate the extent of apparent soil contamination. The exact locations of these borings were also not documented. Based on site sketches, these borings appear to be located immediately adjacent to the fence, four borings along each length. Soil samples were collected from four depths at each of the borings. Thirty-two soil samples were analyzed for organochlorine pesticides and herbicides, PCBs, and tetrachlorodioxin. The most prevalent detected compounds were 2,4-D, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Thirty out of the 32 samples contained the herbicide 2,4-D. Pesticide, 4,4'-DDD, was detected in the soils down to a depth of five feet. Moreover, pesticides 4,4'-DDE and 4,4'-DDT were detected down to a depth of 3 to 5 feet. PCBs (maximum concentration of 17.1 $\mu\text{g/g}$) were detected in two soil samples located on the northeast corner of the fenced area (near the suspected pit area). A high concentration of chlordane (76.7 $\mu\text{g/g}$) was detected along the northwest portion of the site. (ESE, 1990). Table 1-2 presents a summary of this data.

TABLE 1-2

**SUMMARY OF DETECTED COMPOUNDS IN
CONFIRMATION STUDY SOIL SAMPLES
SITE 21: TRANSFORMER STORAGE LOT 140
REMEDIAL INVESTIGATION CTO-0177
MCB, CAMP LEJEUNE, NORTH CAROLINA**

Detected Compounds	Range of Concentrations (µg/g)		
	Inside of Fence Samples August 1984 ⁽¹⁾	Outside of Fence Samples August 1984 ⁽¹⁾	Outside of Fence Samples November 1986 ⁽³⁾
Aldrin	ND ⁽²⁾ to 0.0011	ND	ND
4,4'-DDD	ND to 0.0074	ND to 0.023	ND to 0.282
4,4'-DDE	ND to 0.074	0.0079 to 0.22	ND to 1.98
4,4'-DDT	ND to 0.087	0.0140 to 2.1	ND to 5.08
Heptachlor	ND	ND to 0.0027	ND
BHC, D	ND	ND	ND to 0.0297
Chlordane	ND	ND	ND to 76.7
PCBs, total	ND	ND	ND to 17.1
2,4-D	ND	ND	ND to 0.685

(1) August 1984 samples analyzed for organochloride pesticides/herbicides and PCBs.

(2) ND = Not detected above method detection limits.

(3) November 1986 samples analyzed for organochlorine pesticides/herbicides, PCBs, and tetrachlorodioxin.

Groundwater Sample Results

During the Confirmation Study, one shallow monitoring well (21GW01) was installed at Site 21 (approximately 50 feet west of the former oil pit) as shown on Figure 1-3. Specific well construction details for this well are unknown; however the well depth was measured at 25.3 feet during the Baker Environmental, Inc. (Baker) RI. A groundwater sample was collected in July 1984 and analyzed for organochlorine pesticides, organochloride herbicides, and PCBs. No compounds were identified in this sample. The well was sampled again in November 1986 and analyzed for organochloride pesticides, organochloride herbicides, PCBs, volatile organic compounds (VOCs), tetrachlorodioxin, total xylenes, methylethyl ketone (MEK), methyl isobutyl ketone, ethylene dibromide, and oil and grease. Only two parameters, 2,4-D (an organochlorine herbicide) and oil and grease, were detected in the 1986 data at a concentration of 1.17 micrograms per liter ($\mu\text{g/l}$) and 400 $\mu\text{g/l}$, respectively (ESE,1990).

1.3.1.2 Aerial Photographic Study Conducted by EPIC

Per the DON's and USEPA Region IV's requests, EPIC conducted an aerial photographic study for Site 21 (the study covered the area of Site 78 which includes Site 21) in 1992. The study covered the period between 1938 and 1990. As depicted on Figure 1-3, piled probable refuse was evident (on the 1944 aerial photograph) along the railroad tracks in the southern portion of the site. Approximately 60 cylindrical objects (possibly transformers) were visible in the north-central portion of the site (1952 finding). A probable stain area north of these objects appeared to be a leaking hose line. This stain continued to be visible in the 1956 and 1960 aerials. Two large stains near the suspected former pesticide mixing area were identified on the 1964 aerial. Two additional probable stain areas were visible in the central portion of the site in the 1984 aerial photograph. Copies of the Site 21 aerial photographs provided by EPIC are presented in Appendix A.

In general, the aerial photographic study corresponded with the previously known information (i.e., the suspected location of the former pesticide mixing). The EPIC Study did not identify the presence of the former transformer oil pit area. It is possible that no aerial photographs were taken during the one year the pit was documented to be used.

1.3.2 Site 24 Previous Investigations

Previous investigations conducted for Site 24 included a Confirmation Study, an Aerial Photographic Study, and a Pre-Investigation Study. These studies are discussed below.

1.3.2.1 Confirmation Study

The findings from the Confirmation Study performed by ESE as they pertain to Site 24 are described below.

Groundwater Sample Results

Five shallow monitoring wells (24GW01 through 24GW05) were installed and sampled in July 1984 to determine the presence or absence of contaminants in the groundwater. The location of these wells is shown on Figure 1-4. Specific well construction details for these wells are not available; however the wells were reported to have been installed at a depth of 25 feet with a 20-foot screen length (from 5 to 25 feet). Two of the wells (24GW01 and 24GW02) were installed on the downgradient side of the Borrow and Debris Disposal Area, two wells (24GW03 and 24GW04) were installed on the downgradient side of the Fly Ash Disposal Area, and one well (24GW05) was installed upgradient of the site. One round of samples was collected from each of the five wells and analyzed for VOCs and the following metals (total): arsenic, chromium, copper, lead, nickel, selenium, and zinc (ESE, 1990).

A summary of the 1984 analytical results is presented in Table 1-3. Chromium, copper, and zinc were detected in both samples collected downgradient of the Borrow and Debris Disposal Areas. Each well contained low levels of either benzene, chloroform, or methylene chloride. The chemical data suggested that, at a minimum, low level contamination at the suspected disposal areas was present (ESE, 1990).

In 1986, two additional shallow monitoring wells (24GW06 and 24GW07) were installed (reported to be 25 feet in depth with 20-foot screen lengths) downgradient of the fill areas as depicted on Figure 1-4. All seven of the monitoring wells (24GW01 through 24GW07) were resampled in December 1986 and analyzed for VOCs and the following metals: arsenic, chromium, hexavalent chromium, copper, lead, nickel, selenium, and zinc. For the most part, the results were consistent with the earlier sampling results (ESE, 1990).

TABLE 1-3

**SUMMARY OF DETECTED COMPOUNDS FROM THE CONFIRMATION STUDY
SITE 24: INDUSTRIAL FLY ASH DUMP
REMEDIAL INVESTIGATION CTO-0177
MCB CAMP LEJEUNE, NORTH CAROLINA**

Detected Compounds	Applicable Groundwater Criteria		Range of Groundwater Concentrations (µg/L)							Applicable Surface Water Criteria	Range of Surface Water Concentrations (µg/L)				Range of Sediment Concentrations (mg/kg)			
	Federal MCL (µg/l)	NC WQS (µg/l)	24- (1,2) GW01	24- (1,2) GW02	24- (1,2) GW03	24- (1,2) GW04	24- (1,2) GW05	24- (2,3) GW06	24- (2,3) GW07	NC Standards for Freshwater (µg/l)	24- (1,2) SW01	24- (1,2) SW02	24- (2) SW03	24- (2) SW04	24- (1,2) SE01	24- (1,2) SE02	24- (2) SE03	24- (2) SE04
Benzene	5	1	ND ⁽⁵⁾	ND	ND	ND	ND-3	ND	ND	--	ND	ND	ND	ND	NA ⁽⁶⁾	NA	NA	NA
Chloroform	-- ⁽⁴⁾	0.19	ND-1	ND	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	NA	NA	NA	NA
Methylene Chloride	5	5	ND	ND-2	ND	ND	ND	ND	ND	--	ND	ND	ND	ND	NA	NA	NA	NA
Trans-1,2-Dichloroethene	100	70	ND	ND	ND	ND	ND	ND	ND	--	ND-2.7	ND	ND	ND	NA	NA	NA	NA
TCE	5	2.8	ND	ND	ND	ND	ND	ND	ND	--	ND-7.1	ND	ND	ND	NA	NA	NA	NA
Arsenic	50	50	ND	ND-3	7.1-9.3	16-47.3	5.6-9.3	ND-5.3	7.5	50	ND	ND	ND	4	ND-1.2	ND-0.3	0.968	5.15
Cadmium	5	5	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	ND-0.3	ND-1.9	ND	2.16
Chromium	100	50	ND-6.6	ND-24	98-130	ND-37	ND	ND-14	52-62	50	ND	ND-9.7	ND	ND	1.6-5.68	3.87-29.3	3.36	33.8
Chromium (+6)	--	--	ND	ND	ND	ND	14.2	ND	ND	--	ND	20.6	ND	ND	ND	ND	ND	ND
Copper	1300	1000	ND-4	ND-8.6	16-17.4	3-7	ND-3	ND	ND-3	7	4.5-5.4	ND-2.8	ND	ND	1-4.19	2-7	2.94	21.6
Lead	15	15	ND	ND	ND-58	ND	ND	ND	ND	25	ND	ND	27.4	ND	4-13.2	12.14-180	10.1	162
Nickel	100	100	ND	ND	61-66	ND	ND	ND	ND	88	ND	ND	ND	ND	ND-0.3	ND-1	ND	ND
Selenium	50	50	ND	ND	5.2-7.6	ND-2.2	ND	ND	ND	5	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	5000	2100	ND-26	ND-87	341-502	ND-8	ND	20-62	69-80	50	11.7-28	ND-20	14.8	6.8	6-13.1	14.7-95	19.5	155

- (1) 1984 samples
 (2) 1986 samples
 (3) 1987 samples
 (4) -- = Not Established
 (5) ND = Not detected above method detection limits.
 (6) NA = Not Analyzed

In March 1987, wells 24GW06 and 24GW07 were resampled. The results from well 24GW06 indicated concentrations of arsenic (5.3 µg/l), chromium (14 µg/l), and zinc (62 µg/l). Well 24GW07 exhibited concentrations of arsenic (7.5 µg/l), chromium (52 µg/l), copper (3 µg/l), and zinc (69 µg/l) (ESE, 1990).

Overall, several different metals were detected in the groundwater samples collected at Site 24 over the 1984, 1986, and 1987 sampling episodes. As shown on Table 1-3, applicable groundwater standards, [namely the Federal Maximum Contaminant Levels (MCLs)/Federal Action Limit (lead) and the North Carolina Water Quality Standards (NCWQS)] were only exceeded at two sample locations, 24GW03 and 24GW07 for chromium (non-hexavalent) and/or lead. These samples were collected in a well downgradient of the Fly Ash Disposal Area and in a well south of the disposal areas (ESE, 1990).

Surface Water and Sediment

In 1984, two surface water and sediment samples were collected in Cogdels Creek downstream of the disposal areas. The exact locations of these samples were not documented. The samples were analyzed for VOCs and the following metals: arsenic, chromium, copper, lead, nickel, selenium, and zinc. A summary of the analytical results are presented in Table 1-3.

The surface water sample (24SW01) collected immediately downgradient of the disposal locations contained trichloroethene (TCE), trans-1,2-dichloroethene (T-1,2-DCE), copper, and zinc. The surface water sample collected from the downstream location (24SW02) also contained copper and zinc (ESE, 1990).

In December 1986, the two sampling stations were resampled and two additional stations were established (24SW03 and 24SW04). The samples were analyzed for the same compounds as in the 1984 sampling round with the addition of hexavalent chromium. These samples contained the same metals at concentrations similar to the 1984 samples. TCE and T-1,2-DCE were not detected in the 1986 sample. The surface water sample collected at the station southwest of the disposal areas contained lead (27.4 µg/l) and zinc (14.8 µg/l) (ESE, 1990). As shown on Table 1-3, the North Carolina Standards for Freshwater were only exceeded at one surface water sample location (24SW03) for lead.

Sediment samples were collected from each of the four surface water sampling stations during the same sampling events. The analytical results, as summarized on Table 1-3, indicated that as many as seven metals were detected in the samples. The lowest concentrations of metals

were identified in the sample collected from the station immediately downgradient of the disposal areas. The sample collected from the tributary to Cogdels Creek contained the highest concentrations of metals (ESE,1990).

1.3.2.2 Aerial Photographic Investigation Conducted by EPIC

In 1992, EPIC conducted an aerial photographic study for Site 24. The study covered the period between 1938 and 1990. Significant findings from this study have been summarized below. Copies of the Site 24 aerial photographs are provided in Appendix A.

As shown on Figure 1-4, a large area of mounded material (no other description included) was noted within and adjacent to the northwestern boundary of the site. This material was first visible in 1943. It was not visible on the 1949 aerial or any other aeriels. It is possible that this material was soil excavated during the various construction activities which took place in the 1940s.

By 1956, activity was visible in two areas in the central portion of the site. The one area (identified as Borrow and Debris Disposal Area), was excavated and a row of stacked objects was visible near the east edge of the area. The stacked objects remained through 1964. The other area (Fly Ash Disposal Area) appeared to be a disposal area containing multi-toned probable refuse and piles of medium-toned and dark-toned material.

By 1960, both of the "disposal" areas contained piles of dark-toned material (possibly fly ash or sewage sludge). Excavated areas including a linear trench are evident within the Borrow and Debris Area. In the Fly Ash Disposal Area, the dark-toned material appeared to have been dumped and spread out in a fairly uniform depth. Rows of stacked objects were visible north of the dark-toned material.

The 1964 aerial photograph shows evidence of increased activity in the Fly Ash Disposal Area. Dark-toned mounded material was visible in a uniform arrangement (such as that created by emptying numerous consecutive dump truck loads). Piled medium-toned material, possible stains, and pools of probable liquid were also evident in this portion of the disposal area. Two piles of light-toned material were visible near the stacked objects. Dark-and medium-toned material was visible in the Borrow and Debris Disposal Area.

In 1970, the Fly Ash Disposal Area looked as if it had been covered and the area appeared to be revegetated. Vegetation was also visible throughout the Borrow and Debris Disposal Area. A mound of light-toned material (possibly the Spiractor Sludge Disposal Area) was identified north of the Fly Ash Disposal Area in 1984.

By 1988, building construction activities were evident in the northeast corner of the site. By 1990, a building and paved area were visible in this location. Various surface water impoundments were noted throughout the study area from 1984 through 1990.

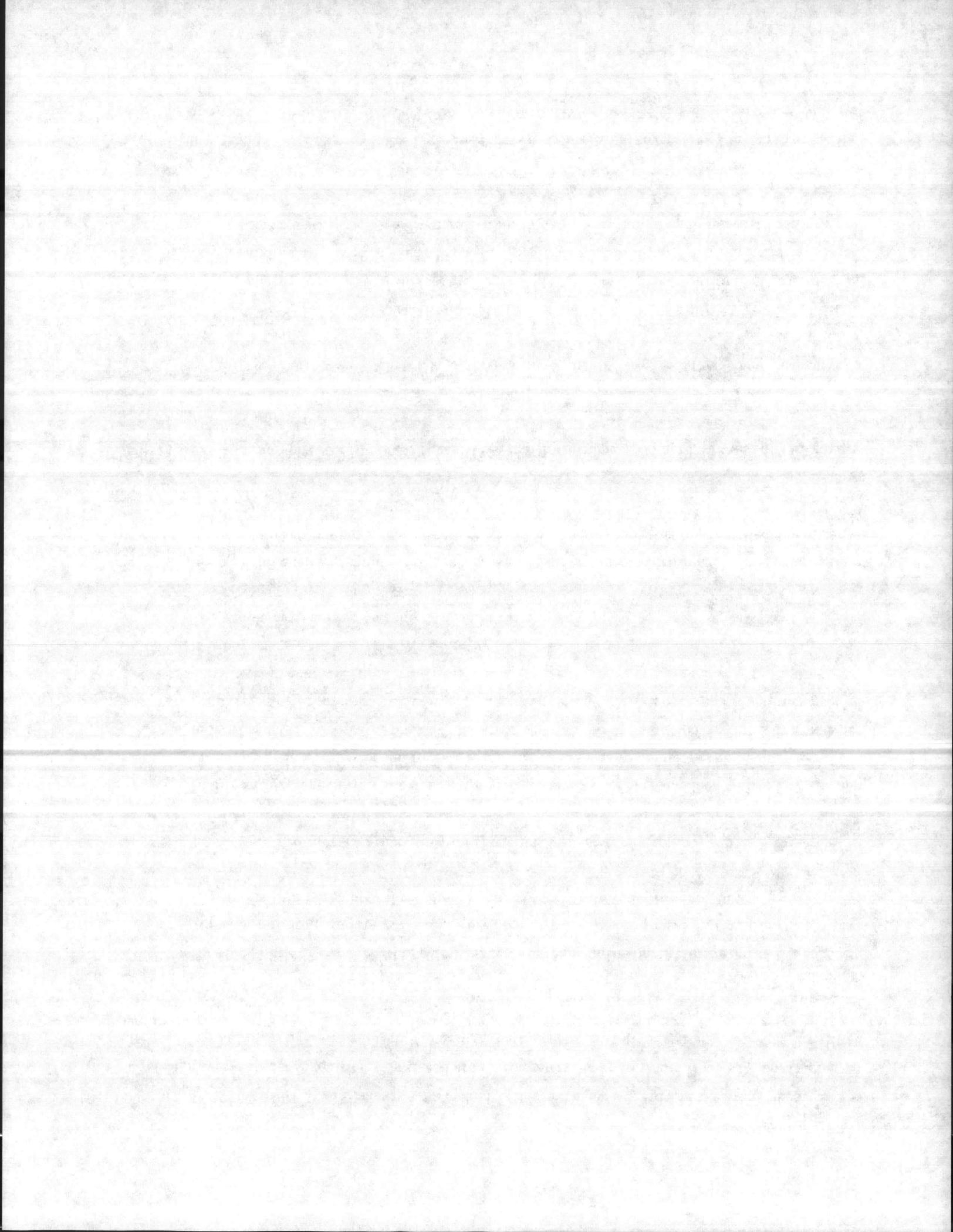
1.3.2.3 Pre-Investigation Study for the RI/FS

In June 1992, a geophysical investigation was conducted by Weston Geophysical Corporation (Weston). The purpose of the investigation at Site 24 was to delineate the boundaries of the four suspected disposal areas. The investigation was conducted by utilizing surface geophysical techniques including electromagnetic (EM) measurements and ground penetrating radar (GPR).

The geophysical survey identified the following:

- The eastern boundary of the Fly Ash Disposal Area which measures approximately 800 feet in length. The western and southern areas could not be identified due to dense vegetation overgrowth.
- The Spiractor Sludge Disposal Area which encompassed approximately 40,000 square feet.
- One Borrow and Debris Disposal Area was identified as part of the geophysical survey.
- Two additional areas containing buried metal were also identified. The first area is approximately 90 by 30 feet and is located south of the Spiractor Sludge Disposal Area and east of the Fly Ash Disposal Area. The second area of buried metal is located north of the Fly Ash Disposal Area. The dimensions of this disposal area are not known.

In July 1992, Baker collected groundwater samples from several of the existing wells. Monitoring wells 24GW01, 24GW02, 24GW03, 24GW04, and 24GW06 were resampled and



analyzed for full Target Compound List (TCL) organics [i.e., PCBs, pesticides, VOCs, and semivolatile organic compounds (SVOCs)] and Target Analyte List (TAL) inorganics (both total and dissolved). Monitoring wells 24GW05 and 24GW07 could not be located and subsequently were not sampled. Analytical results indicated that no VOCs, SVOCs, pesticides, or PCBs were present. Both total and dissolved inorganics detected, in at least one of the wells, included aluminum, arsenic, beryllium, calcium, iron, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, vanadium, and zinc. The Federal MCL and NCWQS for arsenic of 50 µg/l was exceeded in well 24GW04 (total arsenic of 64.5 µg/l). Manganese (total) concentrations in wells 24GW03 (201 µg/l) and 24GW06 (257 µg/l) exceeded the NCWQS of 50 µg/l. In addition, the total lead concentration of 19.2 µg/l detected in well 24GW06 exceeded the Federal Action Limit and NCWQS of 15 µg/l. Analytical data from the July 1992 sampling event are provided in Appendix B.

1.3.3 Site 78 Previous Investigations

Several investigations and studies have been focused on Site 78. The results of the various studies are discussed below.

1.3.3.1 Confirmation Study

As a result of the IAS, ESE was contracted by the DON to investigate Site 78. ESE conducted a two part Confirmation Study which focused on the potential source areas at Site 78. The Confirmation Study included a Verification Step and a Characterization Step. The findings from both of these steps are described below.

Verification Step

The Verification Step of the Confirmation Study for Site 78 was conducted from April 1984 through January 1985. During this study, groundwater quality investigative efforts were conducted at specific study areas within and adjacent to Site 78 (areas identified by the IAS). As part of this investigation, two shallow monitoring wells were installed near the HPIA Fuel Farm (Site 22) to assess whether fuel-derived contamination was present. Site 22 is located north of Ash Street, west of Michael Road, and east of Site 21. (Note that Site 22 is being remediated under the NC State UST Program; therefore, it was not included as part of this RI. The data from Site 22-related monitoring wells will be considered in this RI since the site appears to be connected to OU No. 1.) One shallow well (22GW1 or referred to as 78GW22-1 in

other sections of this RI report) affiliated with Site 78 was installed within the fuel farm area. A second shallow well (22GW2 or referred to as 78GW22-2 later in this RI report) was installed approximately 500 feet northwest of the fuel farm towards Site 21. The results identified the presence of fuel-related VOCs in the monitoring well near the HPIA Fuel Farm and in water supply well HP-602. Supply well HP-602 is a deep well located near the intersection of Holcomb Boulevard and Ash Street, approximately 1,200 feet northwest of the Fuel Farm. Maximum contaminant levels detected in the shallow aquifer included: benzene at 17,000 µg/l and toluene at 27,000 µg/l. Benzene was also detected in supply well HP-602 at a level of 380 µg/l (ESE, 1990).

As a result of the Confirmation Study, Verification Step findings, MCB Camp Lejeune closed supply well HP-602 and initiated a sampling program between December 1984 and November 1986 that included all water supply wells within the vicinity of Site 78. The results of this sampling identified three additional supply wells (HP-601, HP-608, and HP-634) as being contaminated with VOCs. No compounds were detected in the samples from the other nearby supply wells. Table 1-4 presents a summary of the detected compounds found in the supply wells during this sampling program. Maximum contaminant levels in supply wells HP-601, HP-608, and HP-634 included: TCE at 230 µg/l in well HP-601, TCE at 110 µg/l in well HP-608, and TCE at 1300 µg/l in well HP-634. All three of these TCE concentrations exceeded both the Federal MCL and NCWQS for TCE. Other compounds detected in wells HP-601, HP-608 and HP-634 included benzene, T-1,2-DCE, tetrachloroethene (PCE), and methylene chloride. The four supply wells with detected concentrations were immediately shut down by Camp Lejeune utilities staff. Investigations at Site 78 were given the highest priority within the overall Confirmation Study (ESE, 1988).

Characterization Step

The Characterization Step (the final field investigative step in the Confirmation Study process) was performed at Site 78 from 1986 through 1988. The investigation was designed to define the extent of the VOC contamination identified in the Verification Step. The Characterization Step consisted of the following tasks: (1) records search including review of available base records and a physical inspection of each building within Site 78; (2) soil gas survey targeted to those areas identified by the records search as being potential contamination sources; (3) installation of 27 shallow (approximately 25 feet deep), three intermediate (approximately 75 feet deep), and three deep monitoring wells (approximately 155 feet deep); (4) sampling of all Site 78 monitoring wells and nearby water supply wells; and

TABLE 1-4

SUMMARY OF DETECTED ORGANIC COMPOUNDS IN CONFIRMATION
 STUDY SUPPLY WELL SAMPLES
 SITE 78: HPIA
 REMEDIAL INVESTIGATION CTO-0177
 MCB, CAMP LEJEUNE, NORTH CAROLINA

Detected Compounds	Range of Detected Concentrations (µg/l)				
	Supply Wells				
	601	602	608	634	637
Benzene	ND ⁽¹⁾	50 - 720	3.7 - 4.0	ND	ND
1,2-Dichloroethane	ND	9.2 - 46	ND	ND	ND
Trans-1,2-Dichloroethene	8.8 - 99	7.8 - 630	2.4 - 8.5	2.3 - 700	ND
Ethylbenzene	ND	8	ND	ND	ND
Trichloroethene	26 - 230	2.2 - 1,600	13 - 110	1,300	ND
Tetrachloroethene	4.4 - 5	24	ND	10	ND
Toluene	ND	10 - 54	ND	ND	ND
Trichlorofluoromethane	ND	3	ND	ND	ND
Methylene Chloride	10	ND	14	130	ND
Vinyl Chloride	ND	18	ND	ND	ND

(1) ND = Detected below method detection limit.

(5) aquifer testing to evaluate the hydraulic parameters of the deep aquifer (ESE, 1992). A brief summary of the findings from these tasks follows.

Records Search

A detailed records and physical search within Site 78 was conducted to identify the presence of potential waste solvent disposal activities that could account for the observed VOC contamination in the aquifer. In many cases, the physical facilities of the buildings (i.e., floor drains, sumps, unmarked pipelines, etc.) were inspected. The results of this search, which are presented in the ESE Characterization Step Report, May 1988, identified the presence of several primary potential source areas for waste solvent material within Site 78. These included:

- Buildings 901, 902, 903 - TCE UST, engine degreasing within a large area between Buildings 902 and 903 and along the railroad lines;
- Building 1100 - former service station, solvent usage, drum of 1,1,2,2-PCE reportedly leaked onto the ground;
- Building 1202 - maintenance shop, VOC storage and usage;
- Building 1300 - cold storage facility and maintenance shop, solvent usage;
- Buildings 1502, 1601, 1602 - heavy vehicle maintenance facility, TCE UST, heavy solvent and petroleum, oil, and lubricant storage and usage, ground staining; and
- Buildings 1709, 1710 - combat vehicle maintenance area, paint shop, and general maintenance area, underground waste tanks, bags of soil labeled as "contaminated".

Soil Gas Survey

A soil gas survey was conducted at each potential source area identified in the records search. The soil gas survey was targeted to those areas identified in the record search and utilized to supplement well placement. VOC contamination was detected in the soil gas at the following building areas: Buildings 901, 902, and 903; Building 1100; Building 1202; Building 1300; Buildings 1502, 1601, and 1602; and Buildings 1709 and 1710. A brief description of the soil

gas findings is presented below. The actual results of the soil gas survey are presented in the Characterization Step Report for Site 78 (ESE, 1988).

TCE vapors were detected between Buildings 902 and 903 at a level of 1,497 parts per billion (ppb). A soil gas sample along the railroad line near Building 901 recorded a TCE vapor level of 570 ppb. These findings and the documented history of TCE usage throughout this area strongly suggested that VOC contamination was present in the groundwater (ESE, 1988).

A single value of TCE (152 ppb) was detected to the west of Building 1100 (ESE, 1988).

TCE vapors were detected in several samples collected around the Building 1202 area (mostly along Gibb Road) at values ranging from 15 ppb to 36,700 ppb. The highest vapor concentrations appeared to be between Buildings 1202 and 1201, and across Birch Street, near Building 1102. These areas correspond with use and disposal history of solvents at Building 1202 (ESE, 1988).

A single value of TCE (295 ppb) was detected on the eastern side of Building 1300. Since Building 1300 has a maintenance shop it was included as a separate potential source of contamination (ESE, 1988).

The soil vapors in the area between Building 1601 and 1502 contained high concentrations of TCE. The detected levels were as high as 703,000 ppb (this was the highest soil gas vapor detected during the survey). TCE vapors were detected at most of the sampling locations surrounding Buildings 1601 and 1502 (ESE, 1988).

TCE was identified in the soil vapors in two locations south of Building 1709. These samples were located adjacent to bags of soil marked as contaminated. The detected TCE concentrations in these two samples were 35 ppb and 53,000 ppb. In several of the samples obtained south of Building 1710, an extremely high method detection limit needed to be employed due to dilution of the samples in an attempt to resolve a large unknown peak in the data. It appeared (possibly by visual observation) that a large amount of oil and grease was present in the soil in this vicinity (ESE, 1988).

Monitoring Well Installation and Sampling

A total of 34 monitoring wells (27 shallow, 4 intermediate, and 3 deep) were installed during this investigation to enable identification of subsurface geologic units, assess groundwater flow directions, and to evaluate geochemical characteristics of the groundwater at Site 78. The shallow wells included 78GW01 through 78GW26 and 78GW29. The intermediate wells included 78GW04-2, 78GW09-2, 78GW17-2, and 78GW24-2. The deep wells included 78GW04-3, 78GW09-3, and 78GW24-3. Well construction details for these wells (and for other wells installed later at the site) are provided in Table 1-5. The locations of these wells were based on the soil gas survey data and conclusions. The 34 wells plus two shallow monitoring wells previously installed at Site 22 (labeled as 78GW22-1 and 78GW22-2 on Figure 1-5) and five MCB Camp Lejeune water supply wells (HP-601, HP-602, HP-603, HP-608, and HP-634) were sampled and analyzed as part of the Characterization Step (ESE, 1988). Figure 1-5 shows the location of the wells installed during the Characterization Step, the two wells associated with Site 22, the water supply wells, and additional wells installed during a later study of the site.

The shallow wells at Site 78 and the existing monitoring wells at Site 22 were sampled three times: January 1987, March 1987, and May 1987. Analytical results indicated that three primary zones of contamination were present in the shallow aquifer at Site 78, centered in the vicinity of Building 902, Site 22, and Building 1602 (ESE, 1988). Appendix B contains the analytical data from the Characterization Study.

Analysis of shallow groundwater data indicated a need to evaluate deeper aquifer zones. At each of three potential zones of contamination, an intermediate well (approximately 75 feet deep) and a deep well (approximately 150 feet deep) were installed. The potential source areas included: Buildings 901, 902, and 903; Building 1202; and Building 1601. The analytical results from one round of sampling of these wells identified VOC contamination only in the deep wells near Buildings 1202 and 1601. Note that MEK was the only VOC detected in these wells. MEK was not detected in any of the shallow groundwater samples (ESE, 1988). The analytical results from the Characterization Study are presented in Appendix B.

Aquifer Testing

A 72-hour pump test was conducted utilizing water supply well HP-642, located in the northeast corner of Site 78. This test was conducted to determine the aquifer coefficients for

TABLE 1-5

**SUMMARY OF EXISTING MONITORING WELL CONSTRUCTION
DETAILS**

**SITE 78: HPIA
REMEDIAL INVESTIGATION CTO-0177
MCB, CAMP LEJEUNE, NORTH CAROLINA**

Well No.	Well Depth (feet, below ground surface)	Screen Interval Depth (feet, below ground surface)	Well Diameter (inches)
78GW01	25	5 - 25	2
78GW02	20	5 - 20	2
78GW03	25	5 - 25	2
78GW04-1	24.5	4.5 - 24.5	2
78GW04-2	78	65 - 78	4
78GW04-3	153	140 - 153	4
78GW05	25	5 - 25	2
78GW06	25	5 - 25	2
78GW07	25	5 - 25	2
78GW08	25	5 - 25	2
78GW09-1(1)	25	5 - 25	2
78GW09-2	75	55 - 75	2
78GW09-3	150	130 - 150	2
78GW10	25	5 - 25	2
78GW11	25	5 - 25	2
78GW12	25	5 - 25	2
78GW13	25	5 - 25	2
78GW14	25	5 - 25	2
78GW15	25	5 - 25	2
78GW16	25	5 - 25	2
78GW17-1	25	5 - 25	2
78GW17-2	73	53 - 73	2
78GW18	--(2)	--	--
78GW19	25	5 - 25	2
78GW20	25	5 - 25	2
78GW21	25	5 - 25	2
78GW22-1	25	5 - 25	2
78GW23	25	5 - 25	2
78GW24-1	25	5 - 25	2
78GW24-2	76.5	56.5 - 76.1	2
78GW24-3	148	128 - 148	2
78GW25	25	5 - 25	2
78GW26(2)	25	5 - 25	2
78GW29	25	5 - 25	2
78GW30-2	78	65 - 78	4
78GW30-3	153	140 - 153	4
78GW31-2	78	65 - 78	4
78GW31-3	153	140 - 153	4
78GW32-2	77	64 - 77	4
78GW32-3	153	140 - 153	4

Note: (1) Well was not located during the Baker investigation

(2) -- = Information is not available

Source: ESE, 1992

the deeper aquifer zone. The results, which were analyzed by a number of analytical methods, indicated that the aquifer transmissivity ranged from 6.1×10^3 to 1.3×10^4 gallons per day per foot (gpd/ft). Storativity ranged from 5×10^{-4} to 1×10^{-3} (ESE, 1988).

1.3.3.2 Groundwater Study at the Hadnot Point Fuel Farm

O'Brien and Gere Engineers, Inc. conducted a groundwater study at the Hadnot Point Fuel Farm (Site 22) as part of the MCB Camp Lejeune UST Program. Although this study was conducted for Site 22 and not Site 78, the results are applicable to Site 78 given the proximity of the sites (Figure 1-5).

The fuel farm, constructed around 1941, consisted of 14 USTs and one above ground storage tank. These tanks contained either diesel fuel, leaded gasoline, unleaded gasoline, or kerosene. The purpose of this study was to provide follow-up hydrogeologic services to investigate hydrogeology and evaluate the extent of fuel leakage from the USTs and associated transfer lines. The study included the installation of 20 groundwater monitoring wells in the vicinity of the fuel farm, measurement of groundwater elevation and floating product thickness, and sampling and analysis of groundwater for VOCs. The study concluded that fuel losses of gasoline have likely occurred predominantly through leaks in the transfer lines or valves. Laboratory analyses indicate that the floating product has contributed significant levels of dissolved petroleum compounds including benzene, toluene, xylenes, and ethylbenzene (BTEX) into the groundwater. Trace levels of non-petroleum VOCs including TCE and PCE were also detected within the fuel farm.

Following this investigation, O'Brien and Gere conducted a pump test to determine the hydraulic characteristics of the shallow aquifer. Based on these results, O'Brien and Gere designed a product recovery system and contaminated groundwater treatment system for the fuel farm. The system consisted of four recovery wells, a product recovery tank, an oil/water separator, an air stripper, and activated carbon canisters. The entire system began operation in the latter part of 1991. It is important to note that the recovery/treatment system implemented at the fuel farm is addressing a different yet complimentary phase of the groundwater problem at Site 78 (i.e., this system is addressing the recovery of free phase product). Since the fuel farm area is a UST problem, it is not included as part of the CERCLA RI/FS process, but is being handled as a separate study under the UST Program.

1.3.3.3 Supplemental Characterization Step

A Supplemental Characterization Step, performed by ESE at Site 78 from 1990 through 1991, was designed to further evaluate the extent of contamination in the deep portion of the aquifer and to characterize the contamination within the shallow soils at suspected source locations. This study consisted of 30 soil borings at three suspected source locations identified above (Buildings 902, 1202, and 1601) for the characterization of shallow soil contamination, installation of three additional intermediate monitoring wells and three additional deep monitoring wells, and the collection of samples from all new and existing Site 78 monitoring wells and several nearby water supply wells (ESE, 1992).

Shallow Soil Sample Results

Thirty shallow soil borings were performed at Site 78 to evaluate the extent of shallow soil contamination in three areas of concern (Buildings 902, 1202, and 1601) as part of the Supplemental Characterization Step. Ninety-six soil samples (including nine duplicates) were collected. Eight of the samples and one duplicate were analyzed for full TCL organics and TAL inorganics. The other 87 samples were analyzed for TCL VOCs, pesticides, and PCBs, and toxicity characteristic leaching procedure (TCLP) metals.

In general, the soil samples from the Building 902 area identified 1,2-dichloroethene (1,2-DCE) (55 µg/kg and 120 µg/kg) and TCE (120 µg/kg) at one boring location; and phenanthrene (500 µg/kg), fluoranthene (690 µg/kg), and pyrene (530 µg/kg) at another boring location.

The soil samples from Building 1202 contained ethylbenzene (62 µg/kg) and xylenes (580 µg/kg) at one boring location at a depth of 8 to 10 feet (near the water table depth). The boring near Building 1103 identified pesticides including dieldrin, 4,4'-DDE, and 4,4'-DDT at concentrations ranging from 38 µg/kg to 140 µg/kg at a depth of 0 to 2 feet. The boring located near Building 1300 identified PCBs (PCB-1260) at concentrations ranging from 290 µg/kg to 1800 µg/kg to a depth of six feet. Low levels of the pesticides heptachlor epoxide (12 µg/kg) and endosulfan II (16 µg/kg) were detected in this boring at a depth ranging from 2 to 4 feet. Note that samples were collected near Buildings 1103 and 1300 due to their proximity to Building 1202.

The soil samples collected from the Building 1601 area did not reveal any quantifiable volatile or semivolatile contamination. Pesticides (dieldrin, 4,4'-DDE, and 4,4'-DDT) were detected at

a depth of 0 to 2 feet at one boring location near Building 1601. The detected concentrations of these pesticides ranged from 40 µg/kg to 92 µg/kg. Various metals with the exception of silver and mercury were detected in the majority of all of the soil samples collected at the three building areas (ESE, 1992).

Groundwater Sample Results

Twenty-six of the 27 existing shallow groundwater monitoring wells were resampled and analyzed for full TCL parameters as part of the Supplemental Characterization Step. One of the monitoring wells (78GW18) could not be located. In general, the analytical results indicated that BTEX were identified at the Building 902 area, near the railroad tracks south of Building 902, near the fuel farm (Site 22), and near Building 1601. Other VOCs such as TCE were identified in the same areas in addition to the areas near Buildings 1301, 1709, and 1100 (ESE, 1992).

The results from the intermediate and deep monitoring wells indicated that BTEX constituents were detected downgradient of the fuel farm. BTEX contaminants were also detected near the railroad tracks south of Building 902, near Building 1301, and in the area between Buildings 1601 and 1709. Supply well HP-602 had detectable levels of BTEX. Other VOCs were detected in the wells near the railroad tracks, and near Buildings 1202 and 1601. Supply wells HP-634 and HP-637 also had detected levels of VOCs. SVOCs [such as polycyclic aromatic hydrocarbons (PAHs)] were detected near the railroad tracks and near Building 1202 (ESE, 1992).

1.3.3.4 Remedial Investigation for the Shallow Soils and Castle Hayne Aquifer at HPIA

ESE conducted an RI in 1991 to investigate shallow soils and the upper portion of the Castle Hayne aquifer at Site 78. The purpose of this investigation was to delineate the horizontal and vertical extent of contamination within the shallow and deeper water-bearing zones. In addition, soil contamination within the shallow soils at suspected source locations was characterized as to its nature and extent. This RI report used the data from the previous ESE investigations: Confirmation Study (Verification Step and Characterization Step) and the Supplemental Characterization Step (ESE, 1992).

The RI report concluded that while TCE and other VOCs were the primary concern during the soil gas survey, these compounds were detected in only a few of the soil samples collected. The